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# THE DESIGN AND OPERATION OF INTERMITTENTLY OPERATED WATER PURIFICATION PLANTS

By N. T. Veatch

In our experience in the design and operation of water filtration plants, we have learned that the plant with intermittent operation presents the most difficult problems. The practice in the past has been to depend almost entirely on the filters themselves, for the overall efficiency of the plant, and to give very little attention to the design of the settling and coagulating basins. There is little question but what the action in the basins and in the filters themselves is equally important in getting good and economical results in any filtration plant. This fact is most emphatically true of plants which are operated intermittently.

In cases where the plant is operated perhaps ten hours each day, it is difficult to get the proper conditions of water applied to the filters during the first part of each run, as the floc has almost always settled out so as to cause the first water applied to the filters to be clear, or practically so, and free from floc. The arranging of the basins so as to make it possible to handle this clear water and to prepare it for application on the filters is one of the most difficult features in the design.

It is a pretty well established fact that thorough mixing of the chemical and the raw water when first pumped into the basins is well worth the cost. There is always some question as to just how far it is wise to carry this mixing, as each water presents a separate study in itself. There are so many things that enter into the action, such as temperature, turbidity, etc., that no set length of time can be taken as the proper time for mixing. The length of time also depends on the degree of agitation. If the mixing is obtained by means of mechanically driven agitators, the time required is much less than when obtained by baffling. To meet different temperatures, and different conditions of the water, it is probably best to subject the water to at least thirty minutes of mixing when mechanically driven agitators are used, and at least an hour where baffles are depended upon. These periods are based on the use of alum as a coagulant, and are taken from results obtained at different plants. If lime or lime and iron is used as coagulant, the length of time for mixing would vary, depending upon the results desired, such as to the degree to which it is desired to soften the water, if softening is attempted. The figures given should be considered as general only, and not be construed as the ones to use for any and all waters.

After the water has had the chemical mixed with it thoroughly, the question arises as to the best means of treating in the basins before applying to the filters. This second stage in the treatment should depend on the operation of the plant. If the operation is continuous, we find that the water should be treated in the basins in such a manner as to obtain the greatest amount of sedimentation, and at the same time carry a proper floc over onto the filter beds. In case the operation is intermittent, it is best to give the water the greatest chance for sedimentation, and not attempt to keep any floc in suspension. In this way the water at the start of any run, and at any time during the run, is as near a completely settled water as possible. This would also be the condition of a water which is subject to treatment in large settling basins, before applying to the filters.

To prepare the flocless water obtained as outlined above, for application to the filters, the best plan is to subject it to another thorough mixing. It is well to arrange this secondary mixing so that the chemical can be applied at several different points and periods before the water reaches the filters. We have found that it is convenient to be able to apply coagulant at $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$ and 1 hour periods, just prior to water reaching the filters. The condition of the water, and the temperature should determine the proper place for application.

This paper is meant to deal particularly with plants where the total retention period in the basins is from 4 to 6 hours. In basins of this size it is possible to use the basins as settling and also coagulating basins combined. As indicated, previously, in this paper, if the operation is continuous, the mixing at the entrance to the basins, and proper arrangement of the basins will put the water in good condition for application. However, in intermittent operation arrangements should invariably be made for applying the chemicals just prior to passing the water onto the filters. The design of this secondary treating basin should be given very careful study, as the chemicals should all be decomposed before reaching the filters.

The question may arise as to why it is necessary to design filter plants which operate intermittently. This is a very natural question, as it is unquestionably preferable to operate a filter plant continuously. However, the matter of cost, both first cost and that of operation, must always be considered, and especially in the smaller cities. It is necessary for the engineer to compromise his ideal installation to fit the appropriation, and give his client a plant which will operate at a minimum cost. The average city of less than 3000 people does not operate its water works plant continuously, and almost invariably the entire operation is handled by one shift, and often by one man. It generally proves to be much cheaper to pay the fixed charge on the extra investment necessary to give the city a plant that will fit in with the normal operation of the pumping plant, than to cause the city to change its plan of operation, and add one or two shifts to its operating force.

With a properly designed plant which operates intermittently, the city has a plant which will fit in with its normal operation, and as the city grows nearer the size which would require the maximum capacity of the plant, it can well afford to put on the extra help necessary to operate continuously.

It is evident that there is a great need for good engineering and careful study in the design of basins, for any plant. Some of the discredit which is given to mechanical filtration could have been avoided if proper care had been given to preparing the water for treatment on the filters.